



Energy Technologies Area

Lawrence Berkeley National Laboratory

Future Electric Utility Regulation Series Report #6: The Future of Electricity Resource Planning September 29, 2016

Fredrich (Fritz) Kahrl, Energy and Environmental Economics (E3)

Andrew Mills, Lawrence Berkeley National Laboratory

Luke Lavin, E3

Arne Olson, E3

Nancy Ryan, E3

Lisa Schwartz, Berkeley Lab, Project Manager and Technical Editor

- About the series and webinar housekeeping items – Lisa Schwartz, LBNL (5 min.)
- Presentation (40 min.) – Fritz Kahrl, E3 - lead author, and Andrew Mills, LBNL - author of distributed generation sections of report
- Q&A (15 min.)

Future Electric Utility Regulation Series

- A new series of reports from Lawrence Berkeley National Laboratory taps leading thinkers to grapple with complex regulatory issues for electricity
- Unique point-counterpoint approach highlights different views on the future of electric utility regulation and business models and achieving a reliable, affordable and flexible power system
- Primary funder: DOE Office of Electricity Delivery and Energy Reliability - Electricity Policy Technical Assistance Program
- Reports published to date:
 1. *Distributed Energy Resources (DERs), Industry Structure and Regulatory Responses*
 2. *Distribution Systems in a High DER Future: Planning, Market Design, Operation and Oversight*
 3. *Performance-Based Regulation in a High DER Future*
 4. *Distribution System Pricing With DERs*
 5. *Recovery of Utility Fixed Costs: Utility, Consumer, Environmental and Economist Perspectives*
 6. *The Future of Electricity Resource Planning – Today's topic*
- Additional reports forthcoming: feur.lbl.gov
- Expert advisory group (next slide) provides guidance and review



Advisory Group

- Commissioner Lorraine Akiba, Hawaii Public Utilities Commission
- Janice Beecher, Institute of Public Utilities, Michigan State University
- Doug Benevento, Xcel Energy
- Ashley Brown, Harvard Electricity Policy Group
- Paula Carmody, Maryland Office of People's Counsel
- Ralph Cavanagh, Natural Resources Defense Council
- Steve Corneli, consultant
- Tim Duff, Duke Energy
- Commissioner Mike Florio, California Public Utilities Commission
- Peter Fox-Penner, Boston University Questrom School of Business
- Scott Hempling, attorney
- Val Jensen, Commonwealth Edison
- Steve Kihm, Seventhwave
- Commissioner Nancy Lange, Minnesota Public Utilities Commission
- Kris Mayes, Arizona State University College of Law/Utility of the Future Center
- Jay Morrison, National Rural Electric Cooperative Association
- Allen Mosher, American Public Power Association
- Sonny Popowsky, Former consumer advocate of Pennsylvania
- Karl Rábago, Pace Energy & Climate Center, Pace University School of Law
- Rich Sedano, Regulatory Assistance Project
- Chair Audrey Zibelman, New York State Public Service Commission
- Peter Zschokke, National Grid

- We're recording the webinar and will post it on our web site.
- Because of the large number of participants, everyone is in *listen* mode only.
- **Please use the chat box to send us your questions and comments** any time during the webinar.
- Report authors will present for about 40 minutes.
- Moderated Q&A will follow, with the report authors responding to questions typed in the chat box.
- The report and webinar slides are posted at **feur.lbl.gov**

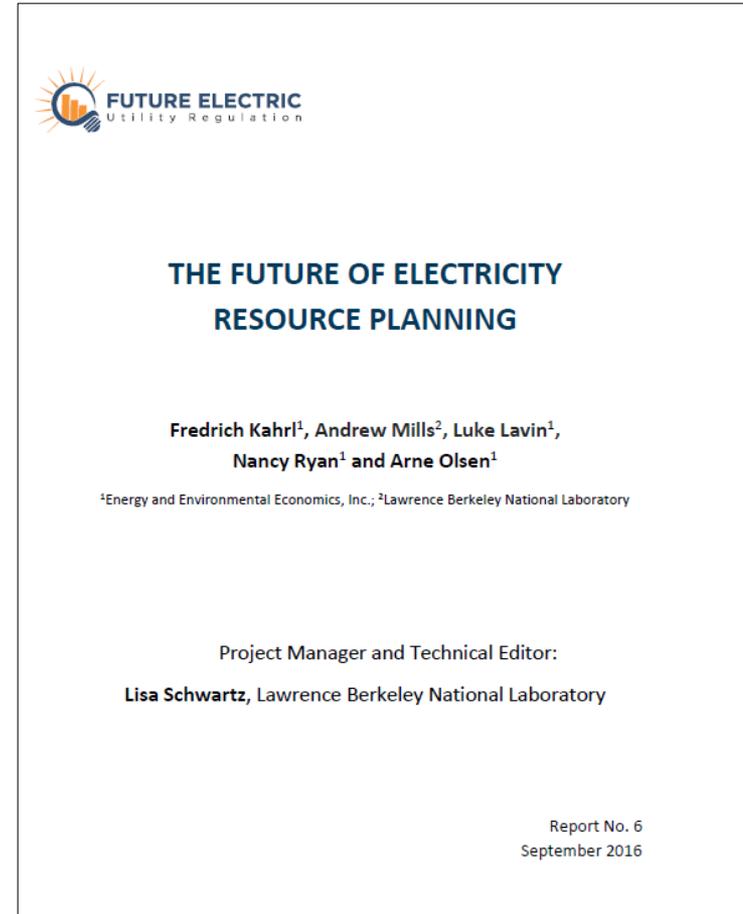
- **Dr. Fredrich Kahrl** is a director at the consulting firm Energy and Environmental Economics, Inc. (E3), where he leads the firm's research efforts and coordinates international work. Kahrl has worked on electricity planning, markets, and regulation in a variety of state and national contexts. He received M.S. and Ph.D. degrees in energy and resources from the University of California, Berkeley, and a B.A. in philosophy from the College of William & Mary.
- **Dr. Andrew D. Mills** is a Research Scientist in the Electricity Markets and Policy Group at Lawrence Berkeley National Laboratory. He conducts research and policy analysis on renewable resources and transmission, including power system operations and valuation of wind and solar. Mills has published his research in leading academic journals and was a contributing author to the International Panel on Climate Change's Fifth Assessment Report and Special Report on Renewable Energy Sources and Climate Change Mitigation. Previously, Mills worked with All Cell Technologies, a battery technology start-up company. He has a Ph.D. and M.S. in Energy and Resources from University of California, Berkeley, and a B.S. in Mechanical Engineering from the Illinois Institute of Technology.
- **Luke Lavin** is an associate at E3, working primarily in the distributed energy resources and resource planning groups. Lavin's recent work includes studies valuing energy storage, distributed solar PV, and other distributed energy resources, as well as work on the California Public Utilities Commission's implementation of a 50 percent renewable portfolio standard. He holds a B.A. in Physics and Anthropology from Amherst College.
- **Dr. Nancy E. Ryan** is a partner at E3, where she leads its work on transportation electrification and works across the firm on policy and strategy projects for a diverse array of public- and private-sector clients. Previously, Ryan served on the California Public Utilities Commission, where she also held a series of high level positions, including Commissioner. She holds a Ph.D. in economics from the University of California, Berkeley, and a B.A. in economics from Yale University.
- **Arne Olson** is a partner at E3, where he leads the company's resource planning group. Olson has worked extensively with regulators and utilities on resource planning in a number of states, including California, Colorado, Oregon, Idaho, Washington and Wyoming. He earned B.S. degrees in Mathematical Sciences and Statistics from the University of Washington, and an M.S. degree in International Energy Management and Policy from the University of Pennsylvania and the École Nationale Supérieure du Pétrole et des Moteurs of the Institut Français du Pétrole.

Please use the chat box to send us your questions and comments any time during the webinar. We'll address as many questions as we can following the presentation.

The report and webinar slides are posted at feur.lbl.gov

- Background
- Paradigm Shift
- Emerging Issues and Evolving Practices
- Summary and Considerations for Regulators

- How is electricity resource planning changing?
- How might it evolve over the next decade?
- What does this imply for state and federal regulators?



- Report examines emerging issues and evolving practices in five key areas:
 - 1) Central-scale generation
 - 2) Distributed generation
 - 3) Demand-side resources
 - 4) Transmission
 - 5) Uncertainty and risk
- Based on analysis, report distills key considerations for regulators

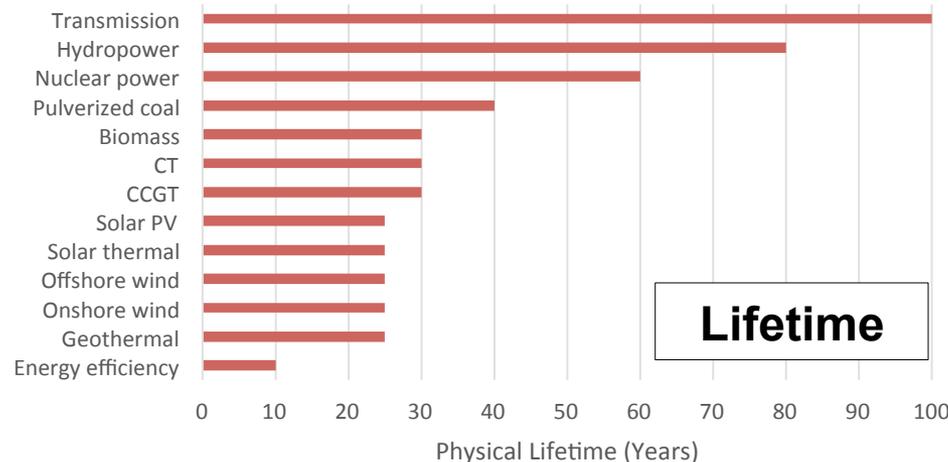
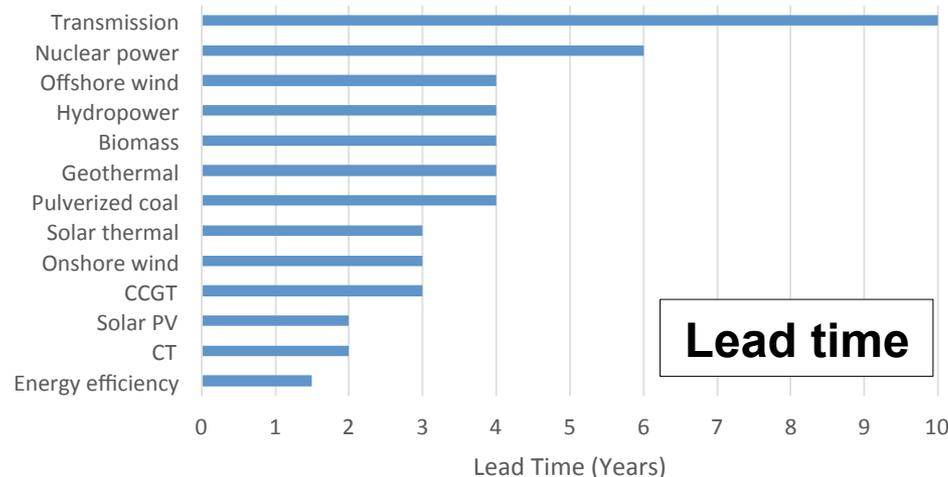
- U.S. electricity sector is complex, variety of planning contexts:
 - Vertically integrated utilities (RTO/ISO or non-RTO/ISO regions)
 - Restructured utilities with limited retail competition
 - Municipal utilities (RTO/ISO or non-RTO/ISO regions)
 - Electric cooperatives
 - Competitive retail providers
 - Federal power marketers
 - And more...
- Planning functions often divided among utilities, state agencies, RTOs/ISOs
- Report seeks to maintain broad perspective and relevance

- Analysis based on review of 10 resource plans:
 - 6 formal integrated resource plans (IRPs)
 - 3 long-term resource plans
 - 1 default service plan
 - Other state agency, RTO/ISO planning documents

Utility	RTO/ISO Region	States Served	Plan Type	Plan Year
Consolidated Edison Company of New York (CECONY)	New York Independent System Operator (NYISO)	New York	Long-range resource plan	2012
Duke Energy Carolinas (DEC)	None	North Carolina, South Carolina	IRP	2014
Florida Power and Light (FPL)	None	Florida	Long-range resource plan	2015
Georgia Power Company (GPC)	None	Georgia	IRP	2013
Hawaiian Electric Companies	None	Hawaii	IRP	2013
PacifiCorp	None	California, Idaho, Oregon, Utah, Washington, Wyoming	IRP	2015
PECO Energy Company (PECO)	Pennsylvania-New Jersey-Maryland Interconnection (PJM)	Pennsylvania	Default service plan	2015
Southern California Edison (SCE)	California Independent System Operator (CAISO)	California	Long-range resource plan	2011
Tennessee Valley Authority (TVA)	None	Tennessee, Alabama, Mississippi, Kentucky, Georgia, North Carolina, Virginia	IRP	2015
Northern States Power Company (NSP)	Midcontinent Independent System Operator (MISO)	Michigan, Minnesota, North Dakota, South Dakota, Wisconsin	IRP	2015

Role of Resource Planning

- Electricity infrastructure often has long lead times and lifetimes
- Key goal of resource planning is to encourage prudent decisions that have long-term implications
- Planning processes provide common reference point on possible futures



- State vs. federal
 - Number of recent federal rules and regulations raise questions about state vs. federal jurisdiction:
 - Hughes vs. Talen
 - FERC Order 1000
 - (subject of forthcoming LBNL report)*
- Planning vs. markets
 - Primarily an issue where utilities play more limited role in procurement (i.e., with competitive retail)

- Background
- **Paradigm Shift**
- Emerging Issues and Evolving Practices
- Summary and Considerations for Regulators

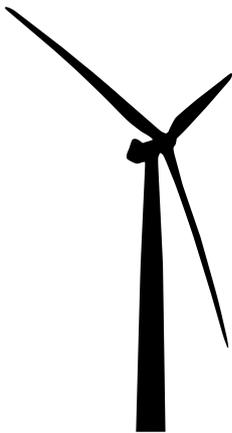
- Six key factors driving major changes in electricity industry
- Changes have significant implications for resource planning, gradual paradigm shift



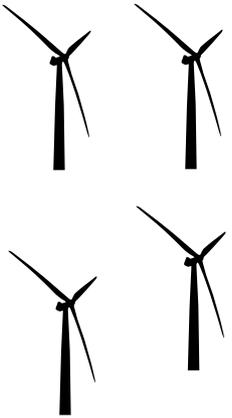
See "Additional Slides"

- Background
- Paradigm Shift
- **Emerging Issues and Evolving Practices**
 - **Central-Scale Generation**
 - **Distributed Generation**
 - **Demand-Side Resources**
 - **Transmission**
 - **Uncertainty and Risk**
- Summary and Considerations for Regulators

- Greatest changes in planning practices for central-scale generation relate to wind and solar
- Different characteristics than other resources:
 - Physical (variable, uncertain)
 - Economic (high fixed cost, very low variable cost)
- Requires planning innovations
- See “Additional Slides”



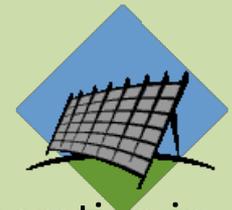
<p>Lower Penetrations</p> <p>Understanding flexibility of existing system, value proposition of RE</p>



<p>Higher Penetrations</p> <p>Making larger changes in operations, investments to accommodate RE</p>

- Key areas:
 - How utilities choose amount and composition of renewable resources
 - How utilities/RTOs assess operational impacts, incorporate into planning
 - How utilities/RTOs assess capacity credits and values for renewable energy

Emerging Best Practices



- Treating wind and solar generation in investment models as “selectable” resources
- Including more detailed operational characteristics in investment/procurement (expansion) models
- Using reliability-based approaches (e.g., ELCC) to determine capacity credit of wind and solar generation
- Coordinating planning across utilities and balancing areas

For examples, see DEC, NSP, PacifiCorp, TVA IRPs

- DG can have significant impact on system operations, need for and timing of investments in conventional generation and T&D infrastructure
- Utilities have limited direct control over adoption
- That said, utilities:
 - Do have some ability to target DG adoption
 - Can plan for DG uncertainty

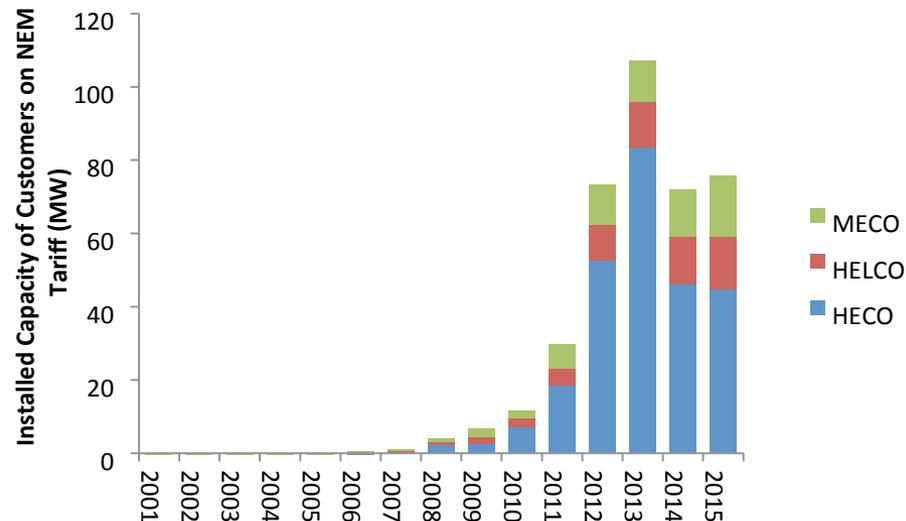


Figure shows net energy metering installations in MECO, HELCO, HECO from 2001 to 2015

In five years customers in MECO, HELCO, HECO install 246, 54, and 58 MW, respectively, of NEM DG (22%, 29%, 30% of 2013 system peak)

- Key areas:
 - How utilities/RTOs are modeling DG adoption and its impact on bulk system planning variables
 - How utilities are valuing DG in resource plans
 - How utilities and regulators are comprehensively assessing DG impacts, beyond traditional resource planning

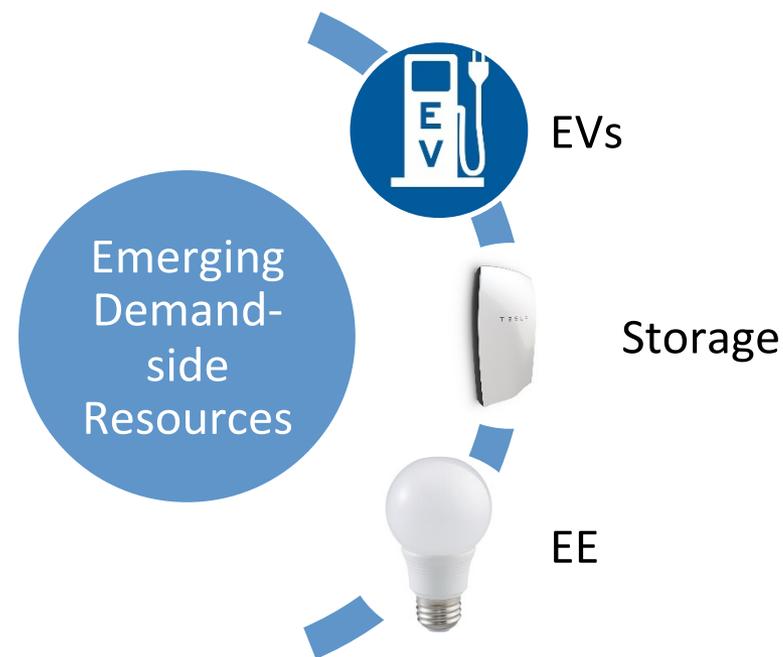
Emerging Best Practices



- Generating DG forecasts using models of customer adoption behavior in resource planning process
- Assessing locational value of DG, incorporating distribution deferral values in DG evaluation
- Making use of “triggers” and “signposts” to revisit plans if adoption is significantly different than anticipated

For examples, see CECONY, NSP, PacifiCorp, TVA plans; SCE DRPs

- Value of demand-side resources (DERs)—EE, DR, storage—will likely increase over next decade
 - Driven by public policy goals
- New opportunities:
 - New kinds of DER resources (EVs, distributed storage), new IT, new business models
- However, DER planning often not well integrated into supply planning, not included in risk analysis



- Key areas:
 - How DER planning is integrated into resource valuation and selection, including risk analysis
 - How retail rates and rate design impacts are incorporated into DER modeling, load forecasts

Emerging Best Practices



- Treating DERs as selectable resources in bulk expansion models
- Incorporating locational benefits of DERs in resource evaluations
- Integrating evaluation across DERs (including DG)
- Better understanding potential of price responsive loads (e.g., EVs, DG + storage), piloting retail rate designs to provide resource benefits

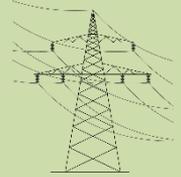
For examples, see CECONY's IDSM tool, PacifiCorp and TVA plans, SCE DRP

- Transmission provides a number of resource benefits
 - Lower costs for capacity, energy, and ancillary services, increased flexibility
- Value of transmission will also likely increase over next decade
 - Public policy goals
- Transmission planning generally not well integrated with resource planning
 - Different questions for RTO and non-RTO jurisdictions



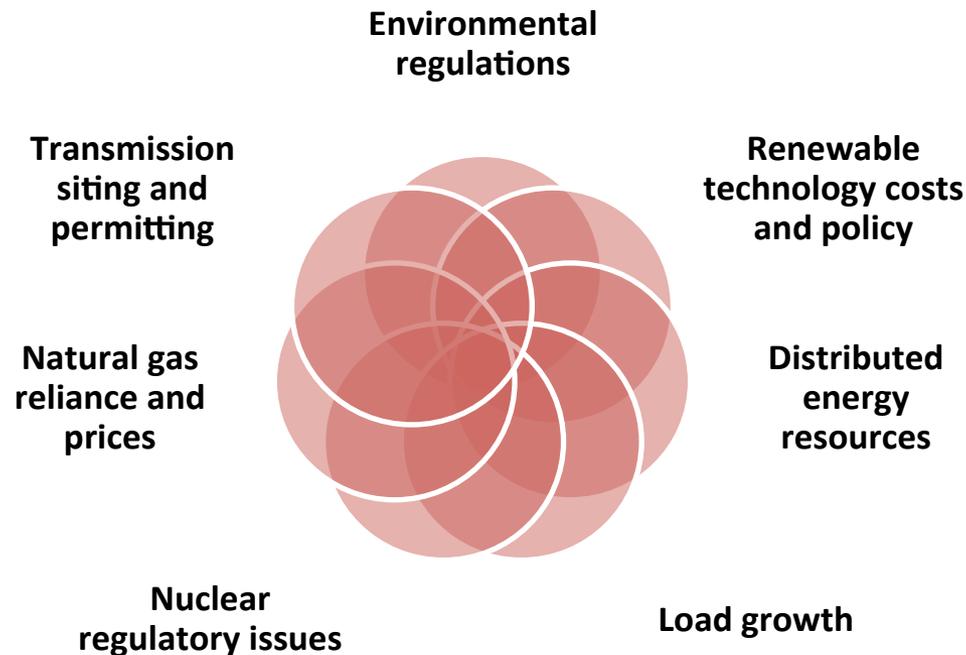
- Key areas:
 - How the capacity, energy, and flexibility benefits of transmission are valued in markets and planning tools
 - How alternatives to transmission are considered in transmission valuation and selection

Emerging Best Practices



- Evaluating multiple benefits of transmission (not just reliability or congestion)
- Incorporating value of reduced wind and solar curtailment
- Coordinating inputs in resource and transmission plans
- Undertaking, and potentially institutionalizing, non-wires alternatives analysis

- Electricity industry has always faced uncertainty and managed risk
- Current levels of uncertainty akin to previous transition periods
 - Drivers of uncertainty often interrelated
- Regulators and utilities should be proactively managing risks



- Key areas:
 - How utilities are incorporating risk into resource valuation and selection
 - How metrics are interpreted and incorporated into preferred plan

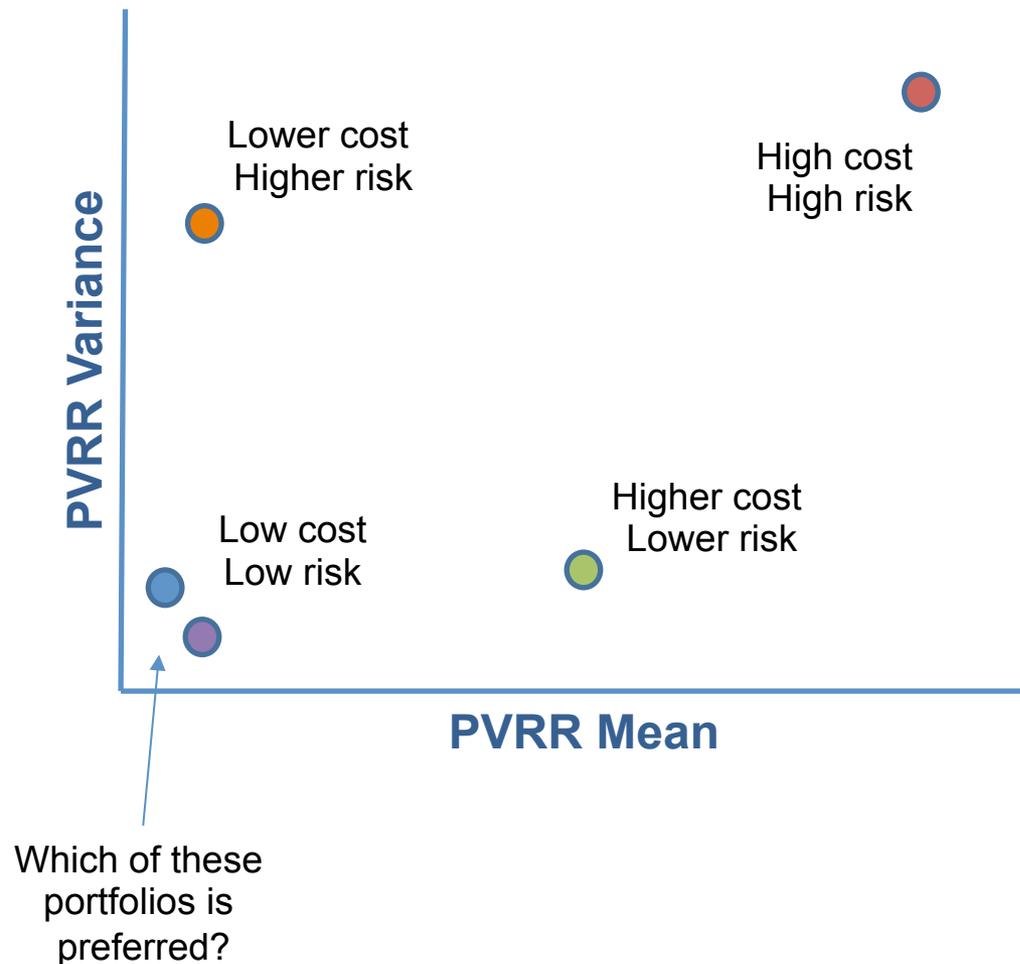
Emerging Best Practices



- Using quantitative risk analysis and risk-adjusted metrics in development of preferred resource portfolio
- Developing clear criteria for how risk-adjusted metrics will be used in evaluating different potential resource portfolios

For examples, see NSP, PacifiCorp, TVA IRPs

- Increased computing power allows screening of portfolios based on average cost and cost variance
 - Systematic sensitivity analysis on resource portfolios
- Selection of preferred portfolio still requires significant judgement



- Background
- Paradigm Shift
- Emerging Issues and Evolving Practices
- **Summary and Considerations for Regulators**

- Electricity industry is changing, resource planning must evolve to keep pace
 - Evolution needs to be in form, function, and methods
- Planning innovations and best practices are emerging, regulators can encourage and support their use
- With better data, new methods, and more computing power, important not to lose sight of the role of judgement in planning

10 Considerations for Regulators

- 1) More integrated approaches to resource evaluation and acquisition
 - Value of integrated planning increases during transition periods
- 2) More comprehensive consideration of investment drivers
 - Shifting from reliability to reliability, environment, risk management
- 3) More accurate representation of solar and wind generation in resource planning models
 - Focus on uncertainty and operational detail, requires industry-wide effort

- 4) Greater attention in resource planning to customer behavior, retail rate designs and the distribution system
 - New opportunities for reducing utility costs and risks, but also new sources of uncertainty and risk
- 5) Risk analysis and use of risk-adjusted metrics
 - Attention to methods and how analysis and metrics are used in portfolio selection

- 6) Balancing precision and transparency in planning models
 - Intuition is still critical, still need back-of-the-envelope analysis and simpler analytical tools
- 7) Coherence between planning and long-term policies and regulations
 - For utilities, understanding costs and non-compliance risks, emphasis on transition
- 8) Deeper expertise at state regulatory commissions and energy agencies
 - Agencies dealing with more complex technical issues, building expertise may require high-level policy support

9) Exploring new opportunities for information sharing and collaboration

- Diversity of inputs and practices, some convergence would be beneficial

10) Regional coordination in resource planning

- Value of coordination and cooperation increases in transition periods



Please use the chat box to send us your questions and comments.

The report and webinar slides are posted at feur.lbl.gov

Lisa Schwartz

Electricity Markets and Policy Group
Lawrence Berkeley National Laboratory

(510) 486-6315

icschwartz@lbl.gov

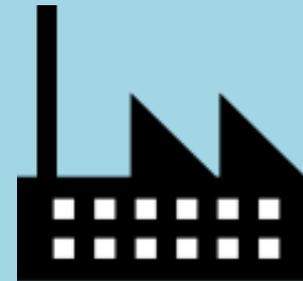
feur.lbl.gov



Environmental Energy Technologies Division Lawrence Berkeley National Laboratory

Additional Slides

- Air quality
 - Mercury and Air Toxics Standards
 - Regional Haze Rule
 - Cross-State Air Pollution Rule
- Water quality
 - Coal Combustion Residuals Rule
 - Clean Water Intake Structures
- Climate change
 - Carbon Pollution Standards for New, Modified and Reconstructed Power Plants
 - Clean Power Plan

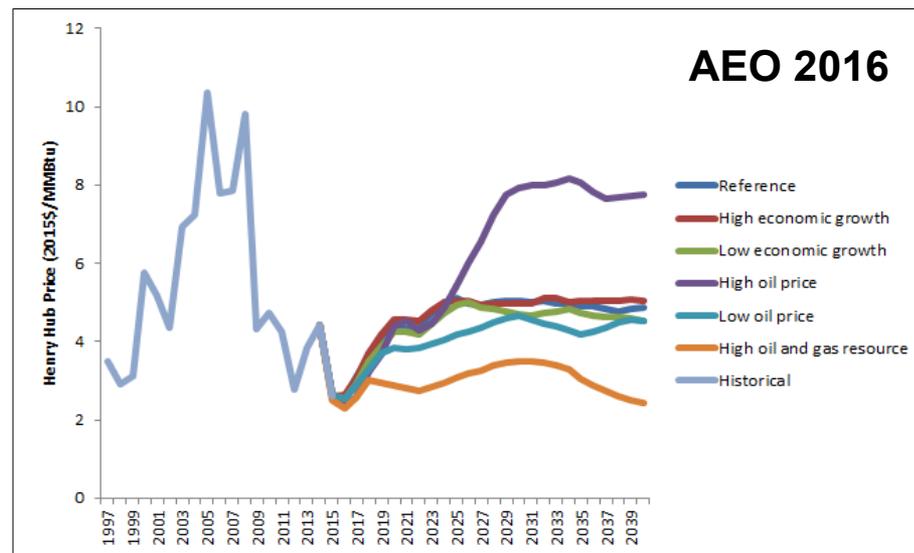
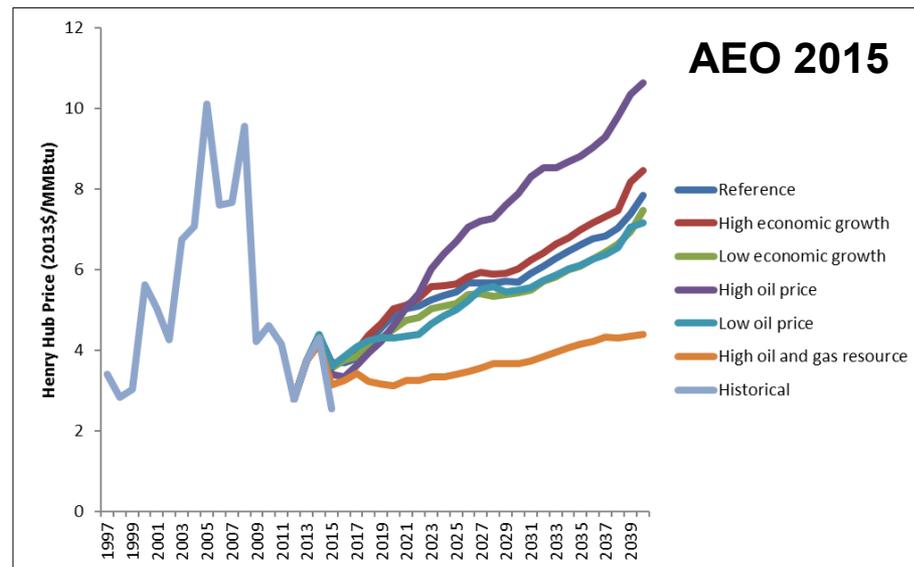


Retrofit or retire?
If retire, replace with what?

Natural Gas Prices

- Natural gas prices currently at historic lows
- Industry becoming increasingly reliant on natural gas generation
- How should natural gas prices be incorporated in resource plans?

Figures show EIA 2015 and 2016 AEO Henry Hub gas price forecasts



Renewable Energy Technology Costs

- Technology costs (\$/kW) for solar have fallen dramatically, wind costs have also come down
- Will these trends continue?
- At what point do we change how we think about them as a resource?

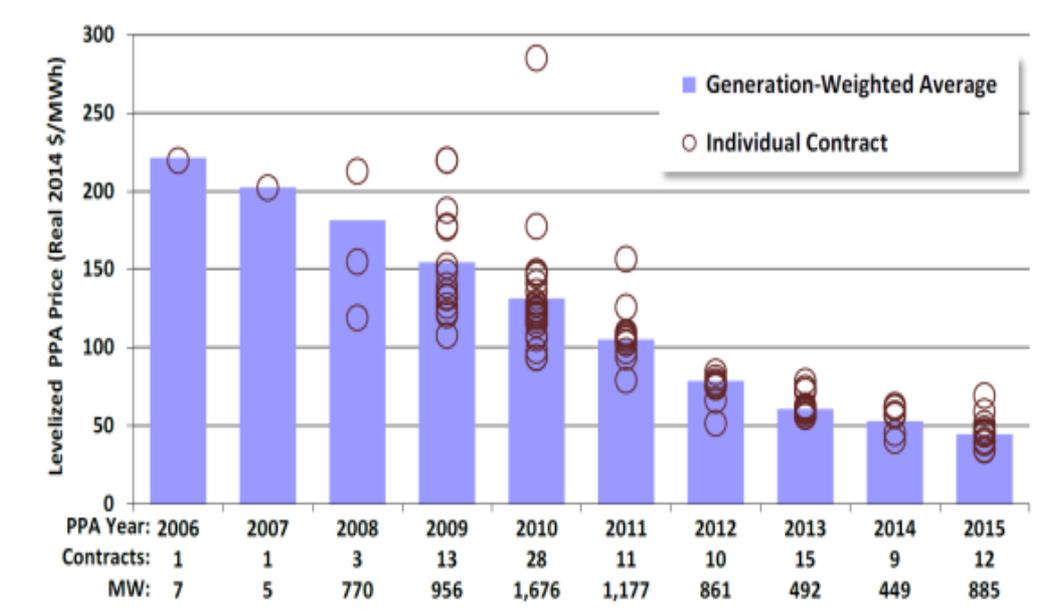
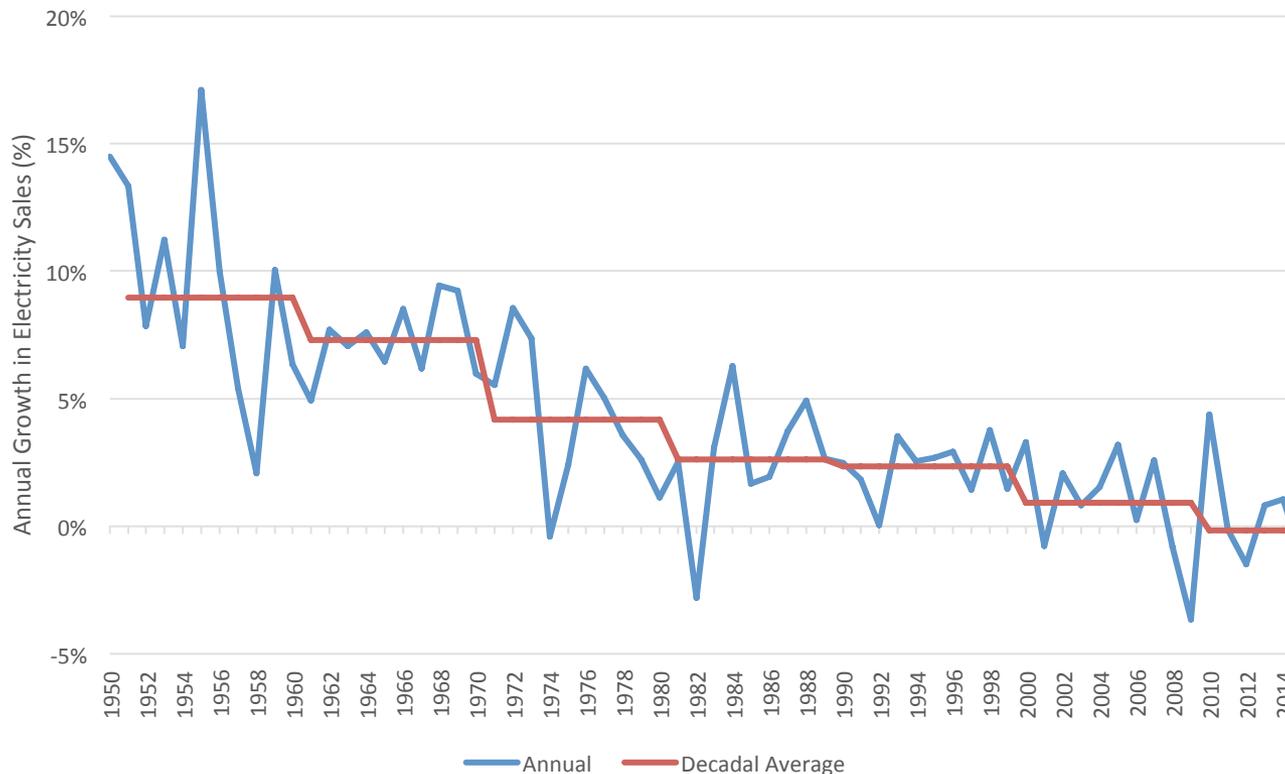


Figure shows solar PPA prices from 2006 to 2015, based on LBNL sample, from Tracking the Sun

Load Growth



Figures shows U.S. electricity industry annual sales growth and decadal averages; data are from EIA

- Industry has seen steady decline in sales since 1970s, but now potentially negative
- How do flat/declining sales affect resource decisions?

Questions for Higher Renewable Penetrations

- Higher penetrations of solar and wind change scope of relevant resource planning questions

Is there flexibility in neighboring systems to absorb additional imports?

Are there cost-effective investments that will reduce curtailment?

Is there more flexibility in current system (e.g., in scheduling, reserves)

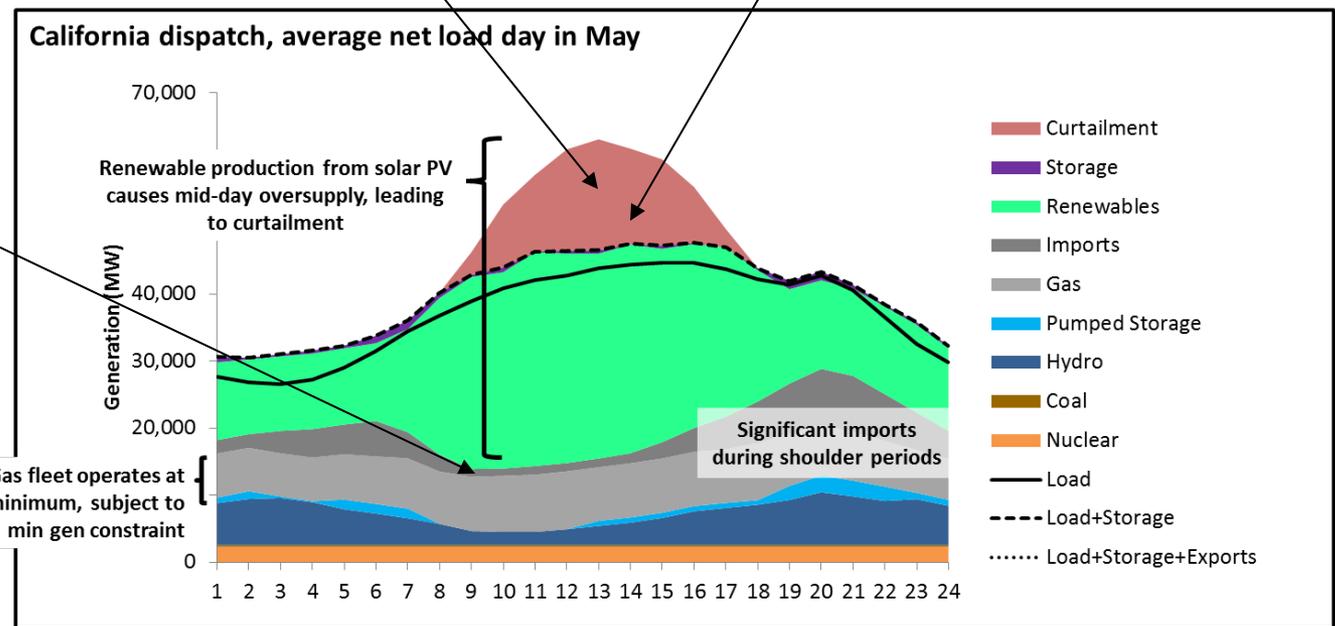


Figure is from E3's Western Interconnection Flexibility Assessment, <https://www.wecc.biz/Administrative/Flexibility%20Study%20-%20E3.pdf>